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Agroforestry systems: Meta-analysis of soil carbon stocks, sequestration processes, and future potentials

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Abstract

© 2018 John Wiley & Sons, Ltd. Agroforestry (AF) has the potential to restore degraded lands, provide a broader range of ecosystem goods and services such as carbon (C) sequestration and high biodiversity, and increase soil fertility and ecosystem stability through additional C input from trees, erosion prevention, and microclimate improvement. Advantages and processes for global C sequestration in AF are unknown. We used a meta-analysis of 427 soil C stock data pairs grouped into four main AF systems—alley cropping, windbreaks, silvopastures, and homegardens—and evaluated changes in AF and adjacent control cropland or pasture. Mean soil C stocks in AF (1-m depth) were 126 Mg C·ha−1, which is 19% more than that in cropland or pasture. The highest C stocks in soil were in subtropical homegardens, AF with younger trees, and topsoil (0–20 cm). Increased soil C stocks in AF were lower than aboveground C stocks in most AF systems, except alley cropping. Homegardens stored the highest C in both aboveground and belowground, especially in the subsoil (20–100 cm). Advantages of AF ecosystem services focusing on mechanisms of belowground C sequestration were analyzed. AF could store 5.3 × 109 Mg additional C in soil on 944 Mha globally, with most in the tropics and subtropics. AF systems could greatly contribute to global soil C sequestration if used in larger areas. Future investigations of AF should include (a) mechanistic- and process-based studies (instead of common monitoring and inventories), (b) models linking forest and crop growth with soil water and C and nutrient cycling, and (c) accurate assessments of the AF area worldwide based on the remote sensing approaches.

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Keywords

agroforestry management, carbon sequestration, ecosystem services, homegardens, meta-analysis, sustainable land use

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